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February 6, 2008

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***BY ELECTRONIC FILING***

Ms. Marlene H. Dortch
Secretary
Federal Communications Commission
445 Twelfth Street, S.W.
Washington, D.C. 20554

**Re: Ex Parte Notice of GE Healthcare**
**ET Docket No. 06-135**

Dear Ms. Dortch:

This letter is to notify you of *ex parte* meetings that occurred today between representatives of GE Healthcare ("GEHC") and various Commission staff. Participating in the meetings on behalf of GEHC were: Neal Seidl, Lead System Designer, Wireless, GEHC; David Davenport, Electronic Systems Engineer, GE Global Research; and the undersigned, counsel to GEHC. We met in separate meetings with: Aaron Goldberger, legal advisor to Chairman Martin; Bruce Gottlieb, legal advisor to Commissioner Copps; Renee Crittendon, legal advisor to Commissioner Adelstein; Angela Giancarlo, legal advisor to Commissioner McDowell; Wayne Leighton, advisor to Commissioner Tate; and Julius Knapp, Bruce Romano, Jamison Prime, Mark Settle and Gary Thayer, all of the Office of Engineering and Technology. In the meeting with Ms. Giancarlo, John Schaeffer of GE Healthcare also participated. During the meetings, the participants discussed GEHC's December 27, 2007, *ex parte* comments filed in the above-referenced proceeding, and the presentation attached hereto.

Pursuant to Section 1.1206(b)(1) of the Commission's rules, I am filing this notice electronically in the above-referenced docket. In addition, I am sending one copy of this notice via e-mail to the Commission staff noted above. Please contact me directly with any questions.

Respectfully Submitted,

*/s/ Ari Q. Fitzgerald*

Ari Q. Fitzgerald
Counsel to GE Healthcare

Enclosure

cc: Aaron Goldberger
Bruce Gottlieb
Renee Crittendon
Angela Giancarlo
Wayne Leighton
Julius Knapp
Bruce Romano
Jamison Prime
Mark Settle
Gary Thayer

# Proposal for Medical Body Area Network Service (MBANS)

## GE Healthcare Monitoring Solutions

Presentation to the FCC

ET Docket No. 06-135

February 6, 2008

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# Meeting objective

"GE Healthcare urges the Commission to move expeditiously by preparing a Further Notice which... proposes the new spectrum allocation and rule changes necessary to make the next generation of [illegible] medical devices a reality."

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# Agenda

1. GE Introduction
2. Body Sensor Networks
   - Description and Benefits
   - Key Requirements
3. MBANS Proposal
   - Proposed Rules
   - Coexistence
4. Feedback and Next Steps

# GE Healthcare

GE Healthcare is a $17 billion unit of General Electric Company. GE Healthcare employs more than 46,000 people in more than 100 countries.

Diagnostic Imaging

Surgery

Integrated Information Technology Solutions

Clinical Systems

LifeSciences

Medical diagnostics

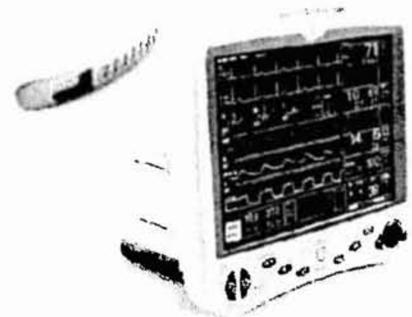
Professional Services

Financial Services

# GEHC Monitoring Solutions is an experienced industry leader in the development of seamless, wired and wireless connectivity and information distribution products and systems.

ApexPro CH   Ambulatory telemetry system operating in the WMTS.

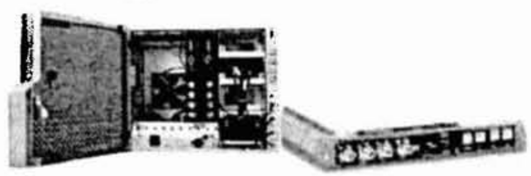
ApexPro FH   Frequency-hopping ambulatory telemetry system operating in the WMTS.



DASH patient monitor   Delivers basic vital signs to ICU monitoring units with built-in wireless LAN.

Web and Mobile Viewer   Provides clinician access to patient data via wireless LAN or cell phone.

Enterprise Access   Multi-use wireless infrastructure (600 MHz – 6 GHz) extends clinical, voice and business application access throughout the enterprise.



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# Challenges to Healthcare

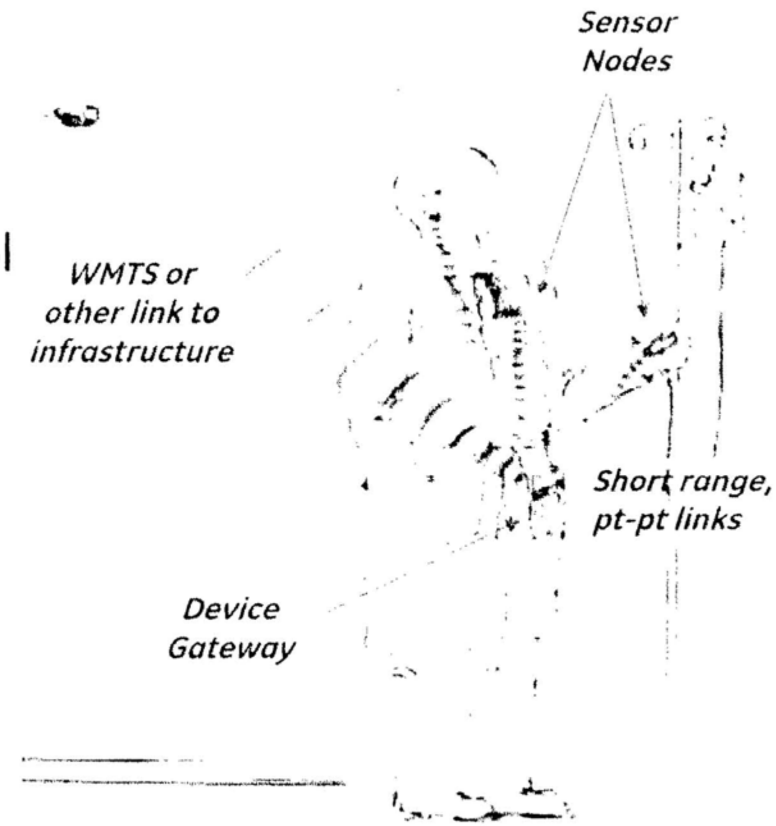
- An aging population
- Sicker, higher acuity patients
- Staff overload and fatigue
- Quality and safety imperatives
- EMR directives
- Tightening margins

# Body Sensor Network (BSN) for medical monitoring

A wireless network of sensors around a patient

## Clinical Benefits

- Patient mobility, comfort, infection control
- Monitoring flexibility and scalability
- Extension of monitoring into care areas that are currently unmonitored
- Reduced clinical errors
- Reduced overall monitoring costs



# GEHC's primary focus for BSN use will be in clinical environments, but other settings should also be allowed.

## Hospital

- ER, OR, ICU, Med/Surgical
- Maternity, pediatrics
- Sleep study, etc.

## Expanding Beyond Hospital

- Ambulance
- Physician office
- Home
- School and Office
- First responders
- Military

# Enabling clinical environment BSNs

## *Needs*

Robust wireless link for bounded data loss

Capacity for patient and sensor density

Coexist with other radios

Battery life for days of continuous operation

Small form factor for body worn devices

## *How's*

Diversity, error control

- Time, frequency, CRC, FEC, ARQ

Symbol rate >> sensor information rate

- Low duty cycle TDMA

Contention protocols

- Frequency agile hopping, Listen-before-talk

COTS transceivers

- Size, cost, basic modulation, simple protocols, low EIRP

Small, efficient antennas

# BSNs require new, protected spectrum for clinical applications

## Unlicensed Bands

- Lack reliability needed for unprocessed, life-critical monitoring data
- Fully utilized by hospital WLAN for mission-critical applications

## 400 MHz MedRadio

- Duty cycle limits force BSN to 3 MHz center of MedRadio band
- 3 MHz insufficient for BSN patient population within hospital

## WMTS

- Limited and disjointed spectrum bands
- Heavily utilized by hospitals for existing telemetry applications
- "Command and control" channel coordination
- Prohibits use in ambulance, home, office

# The proceeding record supports a new spectrum allocation suitable for BSN devices.

- Comments filed by Texas Instruments support allocation of the 2360 – 2400 MHz band for innovative medical applications, including body sensor networks
- Comments filed by Medtronic, Intel, and AMI Semiconductor (AMIS) discuss monitoring applications similar to GEHC's BSNs.
- Alfred Mann Foundation (AMF), Medtronic, and Partners HealthCare state that additional spectrum should be allocated.
- AMF states that the proposed MedRadio band is insufficient for high bandwidth applications like their wideband microstimulator and that WMTS is too congested.
- NDI Medical states that MedRadio device communications should not be limited to healthcare facilities.
- Cleveland FES Center describes a similar high bandwidth / low latency application.
- Partners HealthCare states that WMTS systems are currently at capacity and 2.4 GHz band devices are rapidly proliferating in the hospital, posing a capacity and QOS challenge.
- AMIS discusses the potential for simple, even disposable, wireless devices to reduce health care costs and improve care.

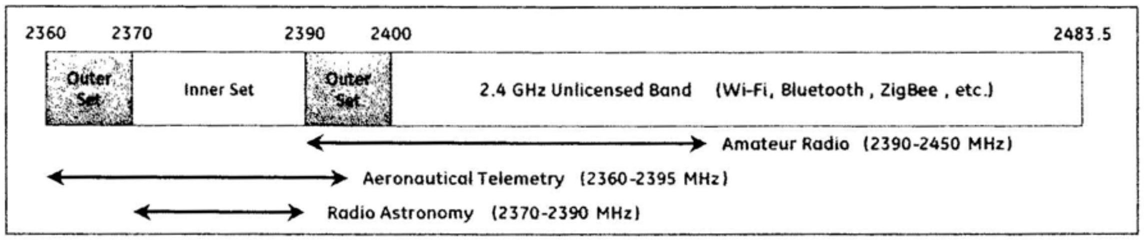
# Proposed Part 95 Rules for MBANS

## Eligibility & Permissible Communications

- Licenses by rule operations by authorized health care professionals (and by any other person, if such use is prescribed by a health care professional). Limited to transmission of data (no voice) used for monitoring, diagnosing or treating patients.

## Frequencies & Authorized Locations

- 2370-2390 MHz (the "inner MBANS channel set") -- limited to health care facilities and other environments where health care professionals monitor, diagnose and treat patients, including in ambulances.
- 2360-2370 MHz and 2390-2400 MHz (the "outer MBANS channel set") -- operations permitted anywhere CB radios may operate.




## Technical Parameters

- All stations must employ unrestricted contention-based protocol.
- Maximum emission bandwidth of 1 MHz.
- Maximum EIRP not to exceed the lesser of 1 mW or 10 log B dBm, where B is the 20 dB emission bandwidth in MHz.
- Same out-of-band (more than 500 kHz outside of band) field strength limits as apply to MICS.

# Why 2360 to 2400 MHz?

- Leverage 2.4 GHz off-the-shelf component integration, capability and volume costs
- Permits small, efficient antennas
- Allows high symbol rate (modulation bandwidth) for low duty cycle and short bursts
- Consultation with NTIA
- Incumbent Aeronautical Telemetry and Amateur operations are good candidates for coexistence

# Why 40 MHz bandwidth?

- Need to share with primary services

  *"Allocating this 40 MHz of spectrum before sharing is taken into account should provide a reasonable expectation of at least 20 MHz being available for secondary use at health care facilities after avoiding frequencies in use by incumbent services."* - *Dec. 27, 2007, Ex Parte of GE Healthcare*

  *Many primary incumbent operations have emission bandwidths of several MHz*

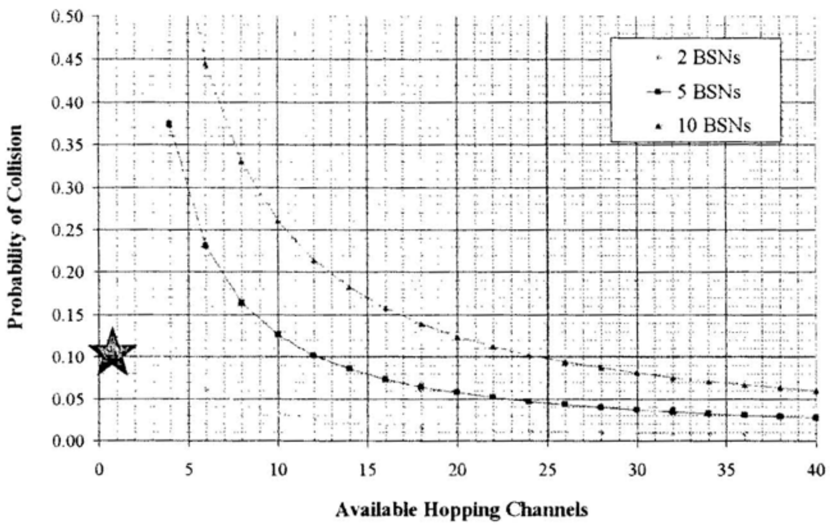
- Frequency diversity given ~10 MHz coherence bandwidth and limited selectivity of off-the-shelf transceiver ICs.

- Hospital patient density

  *10+ patients, 2+ sensors each*

- Uncoordinated, autonomous operation of multiple MBANS devices (contention protocol inefficiency)

# Limiting packet error rate on the BSN wireless link to be no more than 10% provides a reasonable design objective for BSN system performance. Analysis and simulation show 18-25 MHz required for maximum hospital patient/sensor densities.

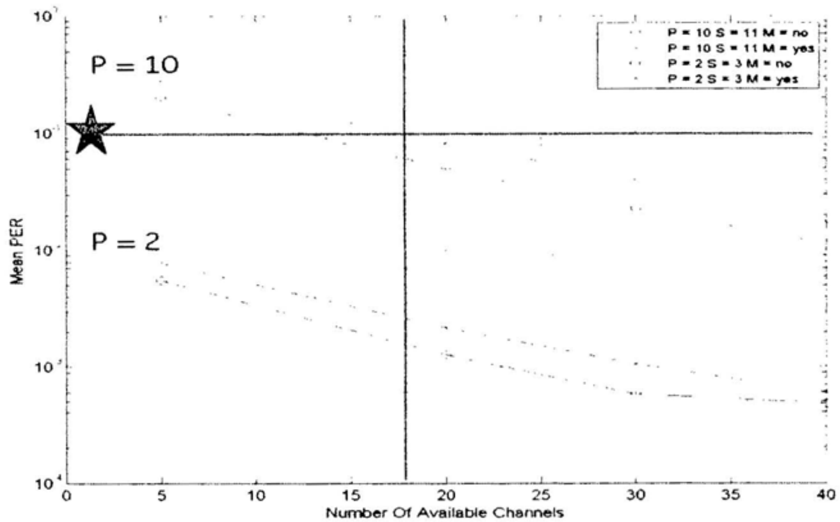



**Upper Bound on Packet Collision Probability for Bluetooth Networks**

$$1-\left[2(1-r)GP_o+(2r-1)(GP_o)^2\right]^{N-1}$$

14. "Interference between Bluetooth networks-upper bound on the packet error rate", A. El-Hoiydi, *Communications Letters, IEEE*, vol.5, no.6, pp.245-247, June 2001.

G = 1 represents 100% traffic load on the Bluetooth network
r = Ratio between packet and slot duration (256us/2ms)
N = Number of interfering networks
Po = Ratio (M-1)/M
M = Number of available frequency channels




**Simulated BSN Collocation Average Packet Error Probability**

BSNs within a 3x3 meter room. Each BSN is a TDMA network with hub and sensors. During each TDMA frame hub and sensors transmit a single packet on a given frequency. Frequency changes every 5 frames in an uncoordinated manner. On-body and body-body propagation has been modeled along with receiver blocking characteristics.

P = Number of patients (BSNs)
S = Number of sensors in each BSN
M = Mobile or stationary BSNs

# Why 1 mW EIRP limit?

On-body propagation measured by GE and addressed in engineering literature *(see Appendix B of Dec. 27, 2007, ex parte for references)*

Path loss assumed lognormal random variable with –63 dB mean and 6 dB standard deviation.

Table 1 – Measured path gain at 2.4 GHz using inverted-L antenna placed 10 mm from skin

| Body Path | Path Gain Average (dB) | Path Gain Standard Deviation (dB) | Path Gain Range (dB) |
|---|---|---|---|
| Left Waist to Right Chest | | | |
| Subject 1 | -57.7 | 5.0 | 35.7 |
| Subject 2 | -60.5 | 6.8 | 60.2 |
| Left Waist to Right Wrist | | | |
| Subject 1 | -68.8 | 6.5 | 56.0 |
| Subject 2 | -63.9 | 5.6 | 58.8 |

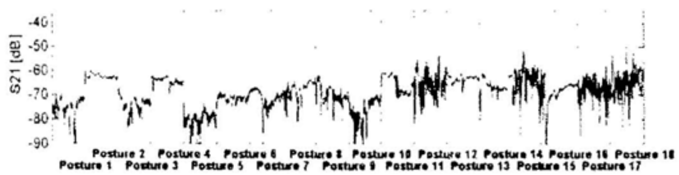



Figure 1 – Path gain measurements for 1 MHz channel at 2.4 GHz using inverted-L antenna placed 10 mm from skin. Multiple body postures considered: standing up, standing turned left, standing turned right, standing leaning forward, standing head forward, standing head right, standing arms out to side, standing arms over head, standing forearms forward, standing moving freely, sitting arms hanging down, sitting hands in lap, sitting moving freely, standing upright, walking back and forth, walking back and forth moving freely.

Performance objective is PER < 10% or BER < $4 \times 10^{-4}$.

Nordic nRF24L01 transceiver specified for BER = $1 \times 10^{-3}$ at –85 dBm signal level.

Assuming noncoherent, binary FSK demodulation, -84 dBm signal level will satisfy the performance objective.

MBANS Link Budget:

0 dBm – 63 dB – (3.5*6 dB) = -84 dBm

1 mW EIRP limit satisfies performance objective with 3.5 sigma = 99.98% reliability.

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# How will MBANS coexist as a secondary service?

1. Physical separation of low power MBANS devices and incumbent receivers

2. Adoption of contention-based protocols

   Frequency hopping, listen-before-talk are effective and proven mechanisms

   - Avoids transmitting on the same frequency as nearby, high power incumbent operations
   - Permits spectrum sharing with other MBANS devices

# Interference link analysis, given physical separation of MBANS and incumbents

Neglecting attenuation from building structures and antenna polarization:

- At 100 meters MBANS signals are at least 6 dB below noise floor of amateur FS-TV and amateur packet/control receivers
- At 218.2 meters MBANS signals meet –8.13 dB I/N level for aeronautical telemetry protection per highly conservative ITU-R M.1459

Excerpt of from Appendix C of Dec. 27, 2007, ex parte

**Table 3 – Coexistence analysis for MBANS with Aeronautical and Amateur Receiver Categories (Path Loss n=2.4)**

| | [A] VICTIM RCVR CATEGORY | [B] FREQ. (MHz) | [C] MBANS EIRP (dBm) | [D] MBANS AND VICTIM DISTANCE (meters) | [E] PATH LOSS, n=2.4 (dB) | [F] RECEIVE ANTENNA GAIN (dBi) | [G] MBANS INTERFERENCE AT VICTIM (dBm) | [H] VICTIM RECEIVER BANDWIDTH (MHz) | [I] MBANS INTERFERENCE IN VICTIM FRONT END RF CHANNEL (dBm) | [J] NET INTERFERENCE TO VICTIM RECEIVER (dBm) | [K] VICTIM RECEIVER NOISE FIGURE (dB) | [L] VICTIM RECEIVER NOISE FLOOR (dBm) | [M] MBANS I/N RATIO (dB) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Amateur fast scan TV, high-rate data* | 1 | 2393.0 | 0 | 10 | 72.02 | -6.0 | -78.02 | 6.0 | -78.02 | -84.05 | 7.0 | -99.19 | 15.15 |
| | 1 | 2393.0 | 0 | 42.8 | 87.17 | -6.0 | -93.17 | 6.0 | -93.17 | -99.19 | 7.0 | -99.19 | 0.00 |
| | 1 | 2393.0 | 0 | 100 | 96.02 | -6.0 | -102.02 | 6.0 | -102.02 | -108.05 | 7.0 | -99.19 | -8.85 |
| | 1 | 2393.0 | 0 | 1,000 | 120.02 | -6.0 | -126.02 | 6.0 | -126.02 | -132.05 | 7.0 | -99.19 | -32.85 |
| *Amateur packet, control/auxiliary* | 2 | 2399.5 | 0 | 10 | 72.05 | -3.0 | -75.05 | 0.005 | -98.06 | -104.08 | 15.0 | -121.99 | 17.90 |
| | 2 | 2399.5 | 0 | 55.7 | 89.95 | -3.0 | -92.95 | 0.005 | -115.96 | -121.98 | 15.0 | -121.99 | 0.00 |
| | 2 | 2399.5 | 0 | 100 | 96.05 | -3.0 | -99.05 | 0.005 | -122.06 | -128.08 | 15.0 | -121.99 | -6.10 |
| | 2 | 2399.5 | 0 | 1,000 | 120.05 | -3.0 | -123.05 | 0.005 | -146.06 | -152.08 | 15.0 | -121.99 | -30.10 |
| *Aeronautical telemetry* | 3 | 2377.5 | 0 | 10 | 71.96 | 0.0 | -71.96 | 10.0 | -71.96 | -77.98 | 2.0 | -101.98 | 24.00 |
| | 3 | 2377.5 | 0 | 100 | 95.96 | 0.0 | -95.96 | 10.0 | -95.96 | -101.98 | 2.0 | -101.98 | 0.00 |
| | 3 | 2377.5 | 0 | 129.3 | 98.63 | 0.0 | -98.63 | 10.0 | -98.63 | -104.65 | 2.0 | -101.98 | -2.68 |
| | 3 | 2377.5 | 0 | 218.2 | 104.09 | 0.0 | -104.09 | 10.0 | -104.09 | -110.11 | 2.0 | -101.98 | -8.13 |
| | 3 | 2377.5 | 0 | 1,000 | 119.96 | 0.0 | -119.96 | 10.0 | -119.96 | -125.98 | 2.0 | -101.98 | -24.00 |

# Incumbents in bands proposed by GEHC

## 2360-2395 MHz

- Federal and non-Federal aeronautical telemetry and telecommand
- Primary amateur operations, including fast-scan TV, high rate data and control – not weak signal operations
- Adjacent ISM at 2400 MHz and radio astronomy at 2380 MHz

## 2395-2400 MHz

- Primary amateur operations, including fast-scan TV, high rate data and control – not weak signal operations

## MBANS Coexistence Mechanisms

- Commission has stated that aeronautical mobile use will be predominantly at remote facilities and at high altitudes such that the potential for interference from terrestrial services sharing the band is small given *"high elevation and off-axis attenuation of high gain flight testing receive antennas on the ground."* - FCC 04-246, Docket Nos. 00-258 and 02-8
- MBANS devices pose minimal risk of interference to high-power, long range (HPLR) operations given their low power, physical separation and use of contention-based protocols.

# Coexistence with aeronautical telemetry (AMT)

## Very low probability of AMT interference to MBANS

- Limited flight test locations and schedules near populated areas
- Building structures attenuate signals from aircraft
- Frequency agility permits MBANS device to change to open channels (including use of the 2395-2400 MHz band with no AMT allocation) for robust operation

# Coexistence with AMT *(continued)*

## Low power MBANS signals present very low probability of interference at AMT receiver

- Very low probability of low elevation, long range testing near urban areas
  - » Multipath interference and electronic noise already limit low elevation, long range flight tests in urban areas
  - » Sec. 15.205 permits spurious emissions at Part 15 general radiated emissions limits; Sec 18.305 permits out of band emissions greater than 15.205
- AFTRCC's arguments rely on overly conservative PFD limits in ITU Recommendation M.1459
  - » Power flux density recommendation based on long range, low elevation operation with high gain directional antenna oriented at interference source
  - » GE analysis assumes 0 dBi to reflect low probability of BSN residing within AMT antenna mainlobe, given azimuth distribution and AMT directionality
- Terrestrial propagation, building structures and antenna polarization misalignment attenuate BSN's low power, low duty cycle emissions
- Contention based protocols facilitate sharing of a channel by multiple BSNs - aggregated signal reaching AMT receiver does not scale linearly with number of BSNs

# Implications of the −180 dBW/m²/4kHz pfd limit from ITU-R M.1459

- Fundamental emissions of a typical 10W EIRP amateur radio transmission would interfere with AMT operations at *radius of 1,370 km* line-of-sight and the spurious OOBE of such operation, even assuming excellent 60 dB suppression, would interfere with AMT operations at *radius of 4.3 km*
- The allowable spurious OOBE from a single 2.4 GHz Part 15 unlicensed intentional radiator would interfere with AMT operations at *radius of over 2.9 km*. Moreover, due to the ubiquity of these devices, the aggregation effects suggested by AFTRCC would greatly compound the effects
- The allowable spurious OOBE from a single 2.4 GHz Part 18 ISM device (e.g. microwave oven) would interfere with AMT operations at *radius of 7 km*
- The allowable spurious OOBE from a single WCS device would interfere with AMT operations at *radius of 17.8 km*

# Conclusion

GE Healthcare requests that the FCC issue expeditiously an NPRM proposing new MBANS rules.

Thank you

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